CHAPTER II

EVALUATION OF OBSERVATIONAL AND FORECAST TECHNIQUES

A. GENERAL

Aerial reconnaissance is the only method available to obtain complete data for the proper analysis of a tropical system. Aerial reconnaissance, being mobile, provides the position, intensity, indications of past movement, changes as they occur, and significant features including eye shape, size and slope. In addition, it provides both surface and upper air data. By using dropsondes, the reconnaissance aircraft is able to obtain the lapse rate profile to the surface, sea level pressure, surface temperature and dew-point at any point of the tropical system.

The accuracy of warnings is directly related to the quality and quantity of aircraft reconnaissance of tropical systems. Continuous surveillance is required on all tropical systems so that initial warning may be promulgated at the earliest possible moment to insure proper preparation for safeguarding property and life.

B. SURVEILLANCE METHODS

During 1963, two aircraft squadrons were assigned the primary responsibility of tropical reconnaissance under requirements of the Joint Typhoon Warning Center, Guam. These units were the U. S. Navy Airborne Early Warning Squadron One (VW-1) which is based at Naval Air Station, Agana, Guam, and the U. S. Air Force 54th Weather Reconnaissance Squadron (54WRS) which is based at Andersen AFB, Guam.

The U. S. Air Force 56th Weather Reconnaissance Squadron based at Yokota Air Base, Japan is the primary backup for the 54WRS. After August and until December 1963, the 56WRS fulfilled all reconnaissance requirements in connection with tropical storm and typhoon fixes which were levied upon the 54WRS. In December, in connection with Typhoon SUSAN, the 54WRS made high level fixes at the 300mb level in conjunction with lower level fixes by the 56WRS during nine scheduled fixes.

The U. S. Air Force 315th Air Division based at Tachikawa Air Base, Japan was the normal CINCPACAF theater air backup.

The various aircraft used by the squadrons are the WB-50 by the 56WRS and by the 54WRS until late August 1963. VW-1 used the EC121K Warning Star and the 315th Air Division used the C-130 aircraft.

During 1963, the 54WRS commenced replacing the WB-50 aircraft with the WB-47 (jet) aircraft and by early September, the transition was complete. The 54WRS first employed the WB-47 to make four fixes on Typhoon ORA during late October. These were considered to be training flights.

Land radar, in conjunction with aerial reconnaissance, was utilized operationally when the tropical system was within radar range. This information was available from various sites using weather radar or tactical radar.

The TIROS weather surveillance satellite offered fixes a number of times during 1963 but did not observe any disturbance in the Western Pacific prior to aircraft reconnaissance or prior to being analyzed on a synoptic chart.

C. EVALUATION OF THE 1963 SEASON

Until the end of August 1963, aerial reconnaissance was divided between the 54WRS and VW-1. After August 1963 and until Typhoon SUSAN in December, the 54WRS placed the JTWC requirements entirely on the Air Force backup squadron, the 56WRS. The only requirements accepted by the 56WRS were on tropical systems of storm intensity or on those forecast to be of storm intensity at the time of the requested fix. After August 1963, with the exception of one fix on a tropical depression, VW-1 was required to make all investigations and tropical depression fixes as well as some daylight storm fixes.

In December, in connection with Typhoon SUSAN, the 54WRS using WB-47 aircraft was requested to make high level fixes. Of the requested fixes, nine were in conjunction with lower level fixes made by the 56WRS for purposes of correlation and compatability. By the time that Typhoon SUSAN reached its maximum intensity, the 54WRS was able to fix the storm very accurately. Several penetrations were made by flying over or through the top of the wall cloud. It is interesting to note that in one case during the early stages of

Typhoon SUSAN the 54WRS reported a "pressure cap" at an altitude of 36000 feet over the storm. A "pressure cap" is defined as an increase in pressure after entering the area over the eye of the storm.

During normal warning status, fixes were scheduled 4 times daily on each typhoon and twice daily on each tropical storm. On many occasions 4 fixes were made daily on tropical systems of storm intensity as well. One daily investigation was scheduled on each tropical depression and as required on each cyclone. Synoptic weather flights which supplement the surface and upper air reporting stations of the U. S. Trust Territories were made as often as aircraft were available. Synoptic flights were quite frequent during the 1963 season. The number of investigation flights were held to a minimum whenever synoptic flights were being made on a routine basis. During 1963, only 5 suspect cyclones were investigated which failed to develop as opposed to 17 in 1962 and 27 in 1961. Synoptic flights were made by the 54WRS and VW-1.

The policy of the JTWC for levying fix requirements on the squadrons were as follows: For typhoon fixes, the 54WRS was requested to make the 2200Z and 0400Z daylight fixes, and the night radar fixes were requested of VW-1 at 1000Z and 1600Z. On some occasions because of time zone considerations, i.e. in the South China Sea and Western Philippine Sea, the 54WRS was requested to make the 0400Z and 1000Z fixes and VW-1 was requested to make the 1600Z and 2200Z fixes. Tropical depressions and cyclone investigations were scheduled for daylight hours by a single squadron. If rapid development was indicated of any tropical depression, then more than one daylight fix of the tropical depression would be requested. The scheduled times for the fixes were within two hours of warning time which provides increased accuracy in the bulletin position. The two hours are considered necessary due to communication difficulties and to allow for proper analyses. With few exceptions, this procedure enabled the Joint Typhoon Warning Center to publish all warnings with the maximum amount of data on hand.

During 1963, the only difficulty encountered occurred after August when all requirements levied upon the 54WRS were transferred to the 56WRS. In order to make the first fix on any tropical system, the 56WRS usually needed 24 hours lead time. Because of other commitments the 56WRS would only make fixes on tropical systems that were of storm intensity or were forecast to be of storm intensity at the time of the requested fix. This situation placed the burden of fixing tropical depressions and investigative type flights on VW-1. VW-1 accepted all JTWC requests for daylight fixes on tropical depressions and investigations as well as all night radar fixes. On some occasions after rapid development, VW-1 also made daylight fixes on named storms. It is worthy to note that VW-1 made over 50 per cent of all fixes and during Typhoon BESS, a total of 25 fixes were made by this indefatigable squadron.

D. EVALUATION OF DATA

1. Aerial Reconnaissance Data

Data received from reconnaissance can be divided into three categories, peripheral, eye data from penetration and eye data from radar.

Peripheral data is all information reported by reconnaissance aircraft enroute and around a tropical system. Eye data from penetration is that data which is reported by the aircraft while in the center of the system. Eye data from radar is a picture description of the eye of the system as it appears on a radar scope at a distance from the center.

Peripheral data includes weather, clouds, flight altitude, wind, temperature, and dew point in addition to surface pressure and estimated surface winds. Dropsondes are released at selected points throughout the tropical system as well as in the center to obtain the lapse rate profile, surface pressure and surface temperature. Dropsondes were made by all WB-50 aircraft and by some EC121K aircraft that had dropsonde chambers installed during 1963. Data from synoptic flights was the same as data received from peripheral flights made in a tropical system. On most synoptic flights, two levels were flown, usually a portion of the flight at 1500 feet MSL and at 700mb level.

The eye data obtained from penetration includes the location of the pressure center as found by radar altimeter. The location was given in degrees and minutes of latitude and longitude during 1963 vice degrees and tenths of degrees during 1962. This method allowed for a more accurate determination of movement of the tropical system. In addition, the flight level wind, 700mb height, maximum 700mb temperature and maximum observed surface wind were reported. Eye characteristics such as size, slope, shape and the extent of cloudiness were reported when possible. During 1963 the geographic center in direction and miles from the pressure center was also reported.

The eye data obtained from radar provides the center of the radar eye and a description of the radar presentation which includes the spiral bands and wall cloud condition. When possible the height of the wall clouds is reported. Frequently the description of spiral bands is used as a parameter for forecasting intensification.

During 1963, daylight penetration of typhoons was scheduled for WB-50 aircraft. EC121K aircraft were not scheduled for penetration due to airframe limitations. However, during some daylight fixes made by the EC121K, penetration was accomplished at the discretion of the aircraft commander. It is interesting to note that on most occasions when turbulence was deemed to be severe was when the tropical system was becoming extratropical. This includes clear air turbulence.

The data obtained by the various squadrons was good with few exceptions. During 1963, crew member experience was extremely good since most members had by this time considerable experience during 1962. The quality of the observations was directly proportional to the experience of the observer. Fixes made at great distances from loran stations or other points of reference did not appear to be as accurate as those made where loran stations or other points were available for navigation purposes. Every effort was made in obtaining radar fixes from as close to the center of the tropical system as possible by the aircraft.

The information received from all reconnaissance aircraft was continually checked for consistency and accuracy. Each piece of information was immediately plotted on the SEAY Graph for continuity with previous data and for consistency with data in the same report. Discrepancies or apparent discrepancies were rechecked with the observing aircraft whenever possible.

2. Land Radar

Land radar was employed in conjunction with aircraft reconnaissance whenever possible. The information which land radar provides includes the position, usually range and bearing and eye characteristics when they can be determined.

Generally, the first few hours of land radar operation led to reports which were not considered to be very accurate. Accuracy generally improved with time and was directly proportional to the experience of the observer. At times land radar reports would indicate that the storm's behavior was very erratic and not consistent with aircraft reconnaissance; this was frequently attributed to inexperienced weather radar observers. In the case of land radar reports made by the Guam tactical radar set, the positions were most frequently excellent and this was attributed to qualified weather radar observers from VW-1 assisting the radar operators.

3. TIROS did not contribute toward discovery of tropical systems, although storms already under surveillance were detected. In 1964, the orbiting TIROS VIII will be followed with great interest because of recently acquired APT capability at FWC Guam.

E. COMMUNICATIONS

Radiotelegraph (CW) is the primary means of communications between the ground and aircraft. AIE2, Andersen AFB, Guam is the primary air-ground contact for aircraft; AIF-8, Yokota AB, Japan is secondary; and AIC2, Clark AB, Philippine Islands is the tertiary contact.

AIE2, Andersen AFB, Guam is responsible for getting reports to JTWC via the local circuit 3L28. This circuit also serves VW-1 and the 54WRS.

When aircraft were in communication with AIE2, all reports were received in JTWC in more than sufficient time, and this enabled the forecaster to make a more comprehensive study of the received data. When the aircraft was in contact with secondary or tertiary contacts quite frequently the reports reached JTWC will little time to spare. This situation arose whenever atmospheric conditions prohibited good communication.

In 1964, it is expected that much use will be made of voice communications on single side band frequencies. The necessary communication equipment has already been installed in JTWC spaces. Reports have been received directly from the aircraft in JTWC spaces, but frequencies for transmission from JTWC to the aircraft have not yet been assigned.

1963 AIRCRAFT RECONNAISSANCE DATA

UNIT	TROPICAL CYCLONES (35)			SYNOPTIC TRACKS
	NO. OF SORTIES	NO. OF FIXES/ INVESTIGATIONS	BONUS	NO. OF SORTIES
VW-1	198	246	1	75
54WRS				
(WB-50)	52	71	-	47
(WB-47)	16	14	-	47
56WRS	89	133	1	1
315AD	1	1	-	--
OTHER USAF	-	-	3	--
OTHER USN	-	-	2	--
CIVILIAN	-	-	1	--
TOTALS				
1963	356	465	8	170
1962	373	496	10	126
1961	304	350	27	---

F. EVALUATION OF NUMERICAL WEATHER PRODUCTS FOR TYPHOON FORECASTING

Beginning with Typhoon BESS in July 1963, JTWC began utilizing the Barotropic 12, 24, and 36-hour 500mb prognostic charts prepared by NWP Suitland, and beginning with Typhoon DELLA in August, the 24, 36, 48 and 72-hour Barotropic 500mb prognostic charts and steering computations from FNWF Monterey were added as aids to typhoon forecasting. Previously, the JTWC used techniques based primarily on current analyses which were man-produced with limited data. There were three reasons for changing over to numerical products as aids to forecasts, and they are as follows:

1. The numerical products offered greater opportunities for future progress.
2. From one synoptic time to another, there is better continuity than man-produced analysis.
3. It adds predicted upper-air circulation patterns as an aid, rather than having all conclusions based upon objective techniques applied to past circulation patterns.

During this season, no attempt was made to develop objective techniques utilizing numerical prognosis. The numerical products were used for their large-scale circulation patterns rather than the detail circulation patterns. Such things as the predicted movement and intensification of ridges, troughs, highs, and lows at 500mb were utilized as aids in determining the paths of typhoons. No attempt will be made to evaluate the numerical prognostic charts numerically, but they will be discussed in terms of their prediction of large-scale features which were used as aids to forecasting typhoons.

In general, the numerical prognostic charts from both Suitland and Monterey were very good aids to forecasting typhoons. Monterey's prognostic charts on a whole were superior to Suitland's for JTWC's purpose for the following reasons:

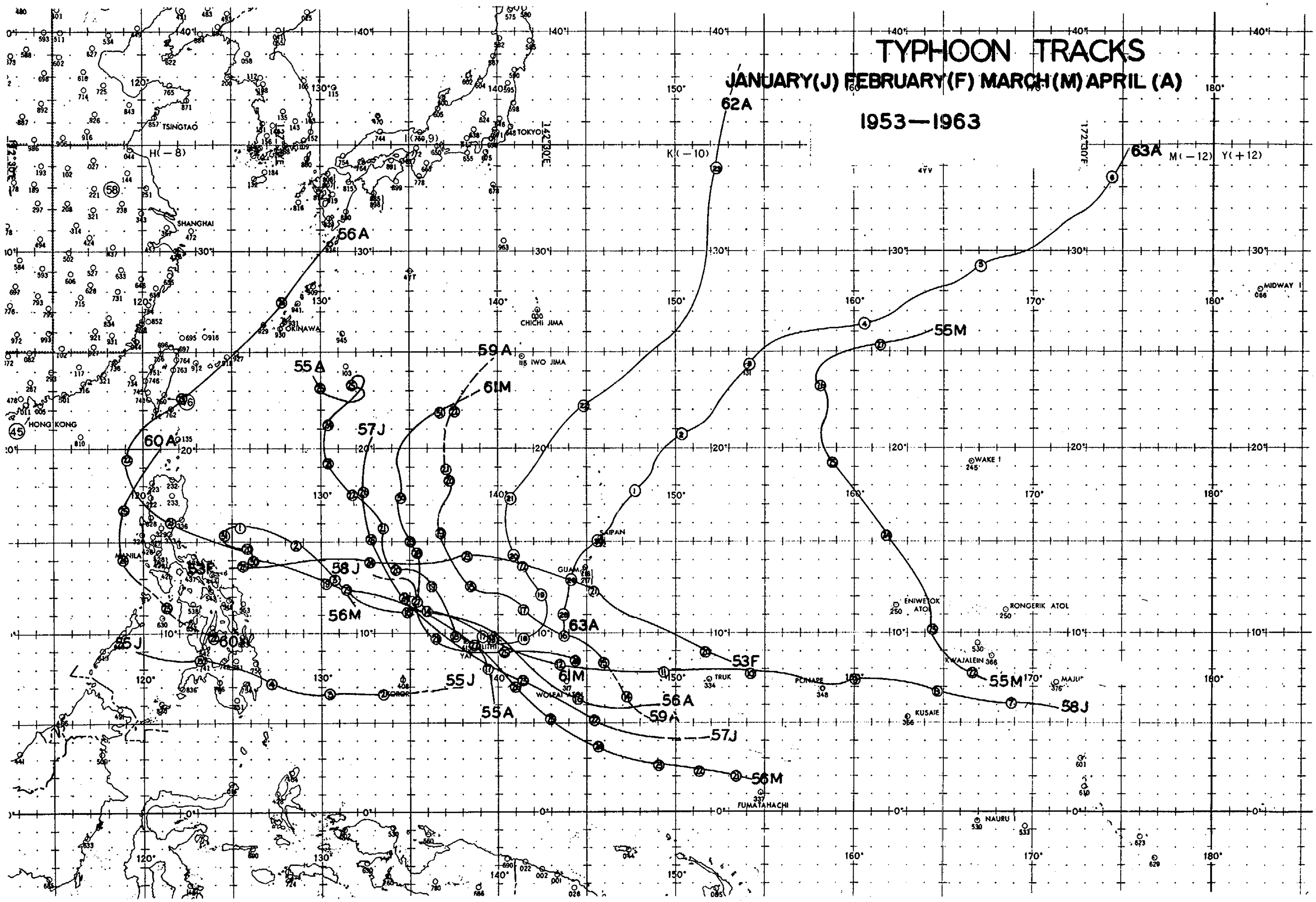
1. Comparing Suitland's 12-hour prognostic charts and Monterey's analysis (JTWC did not have Suitland's analysis), it was evident that Monterey had more data available at the time of prognosis than Suitland did.

2. Suitland's prognostic charts tended to expand the typhoon circulation beyond reason; whereas the Monterey prognostic charts tended to dampen this circulation. Therefore, Monterey's prognostic charts better defined the large-scale circulation patterns.

Postanalysis indicated that when the prognostic charts were of little value, it was mainly the fault of the initial analysis used in preparing the prognostic charts. This was quite evident in the steering computations received from Monterey during the first half of Typhoon SUSAN. Monterey's analysis showed the trough aloft associated with SUSAN always to the east of the storm. In actuality, this was not the case.

In conclusion, the prognostic charts generally were outstanding in forecasting the ridge line north of the storm and showing weaknesses in the ridge line indicating recurvature. These features aided considerably in forecasting typhoons. The results from utilizing the numerical prognostic charts this season are encouraging and would indicate that JTWC now has a good foundation upon which to build a better typhoon forecasting system.

TYPHOON TRACKS, 1953-1963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60A
58J
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56M
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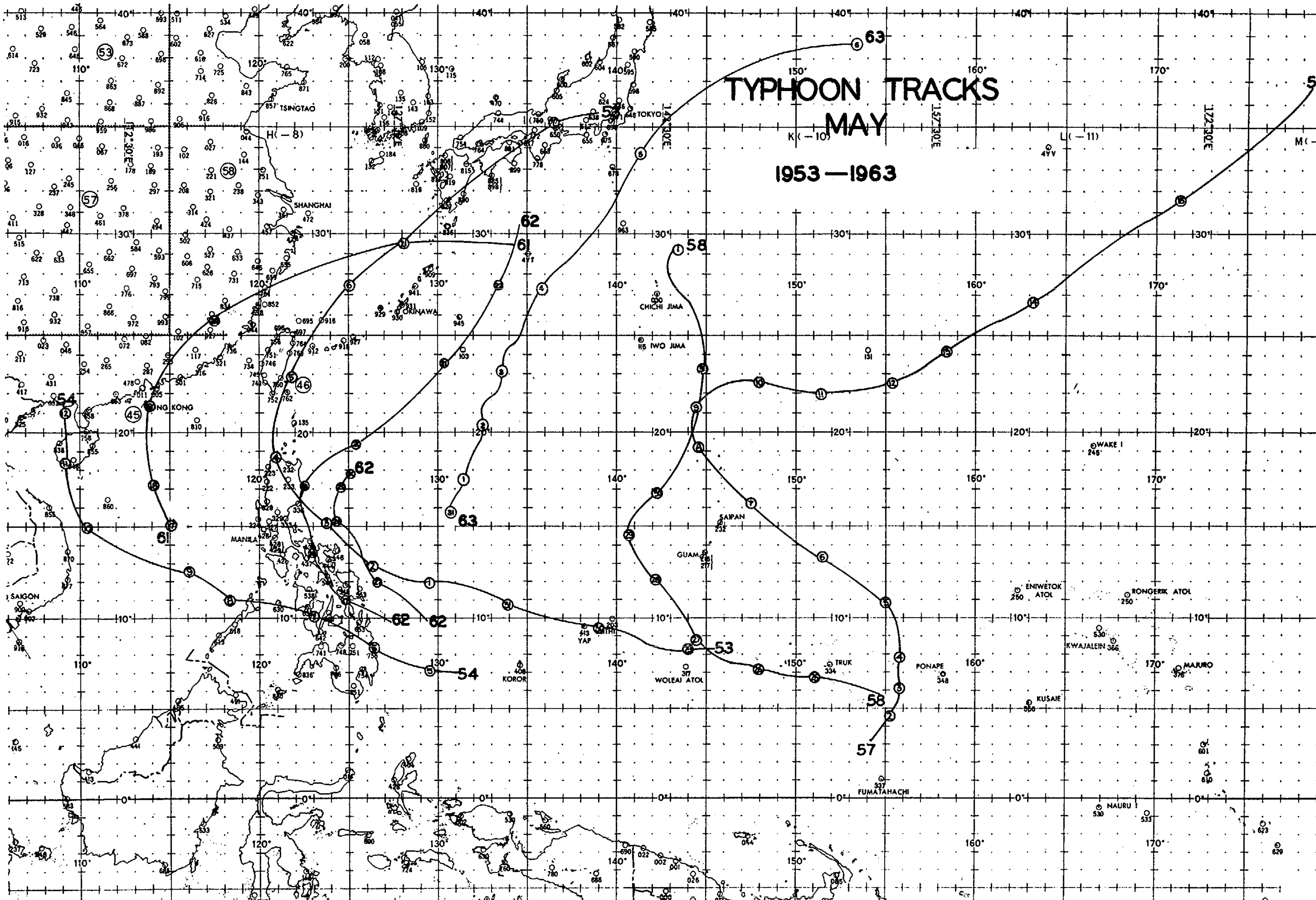
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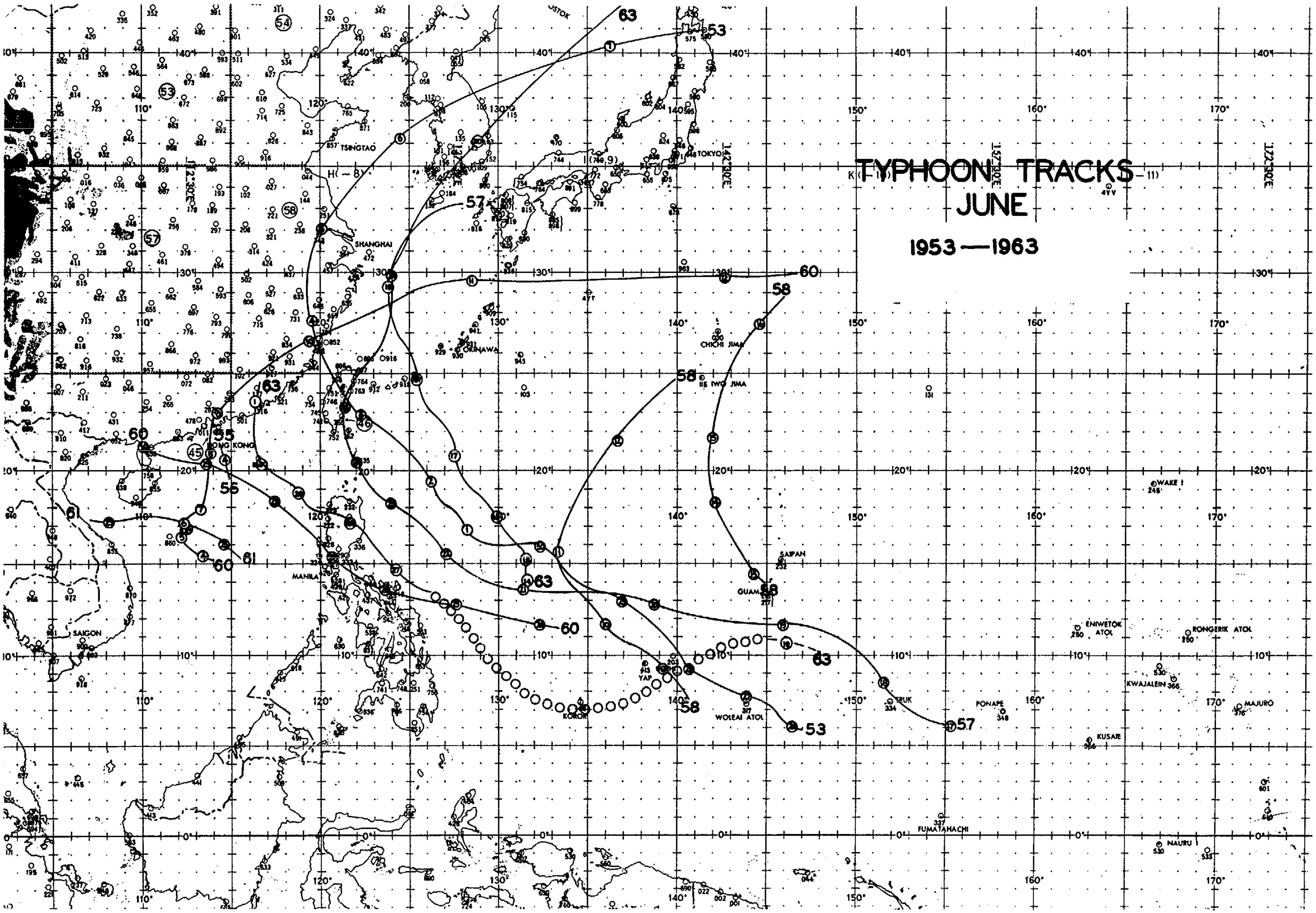
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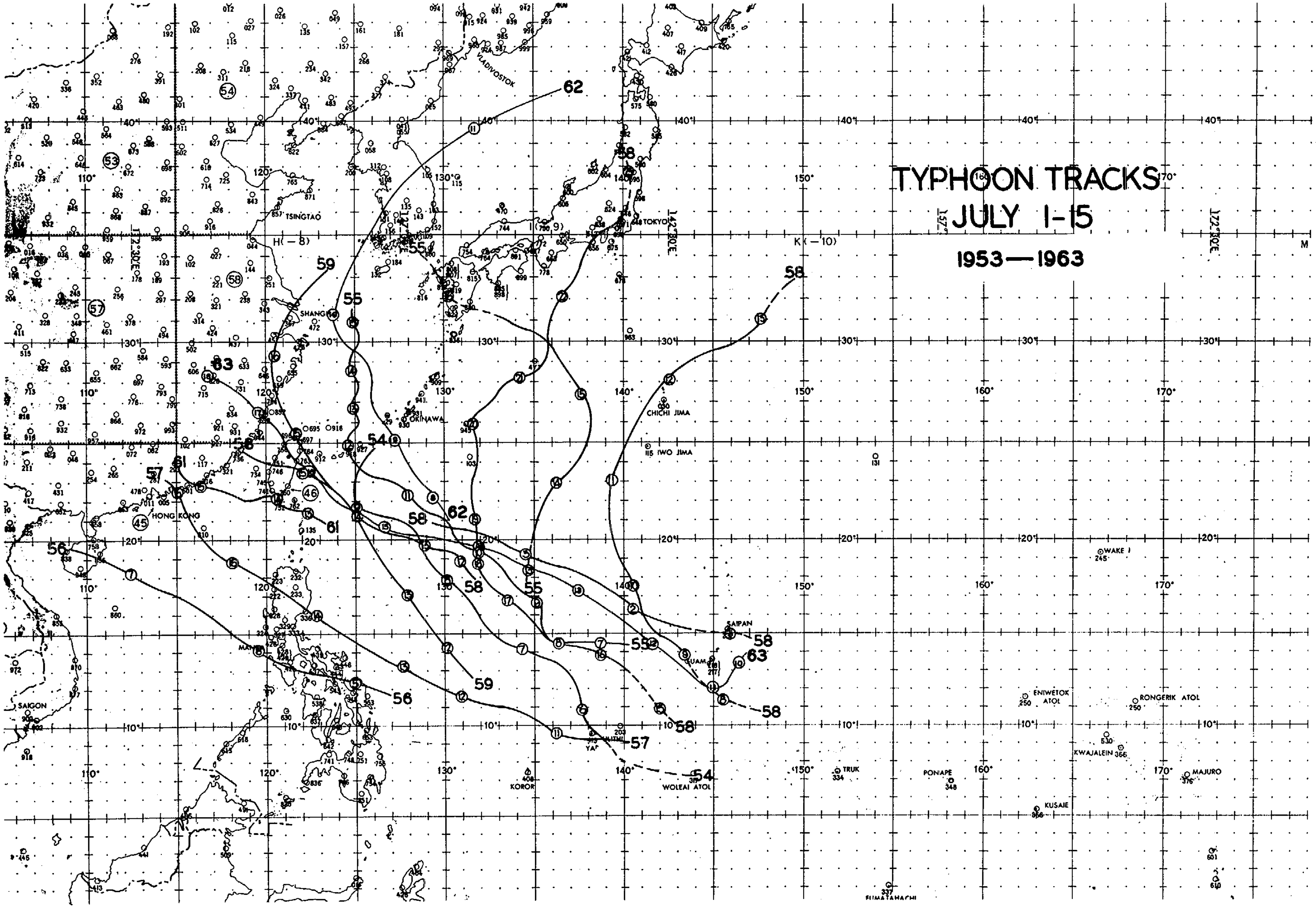
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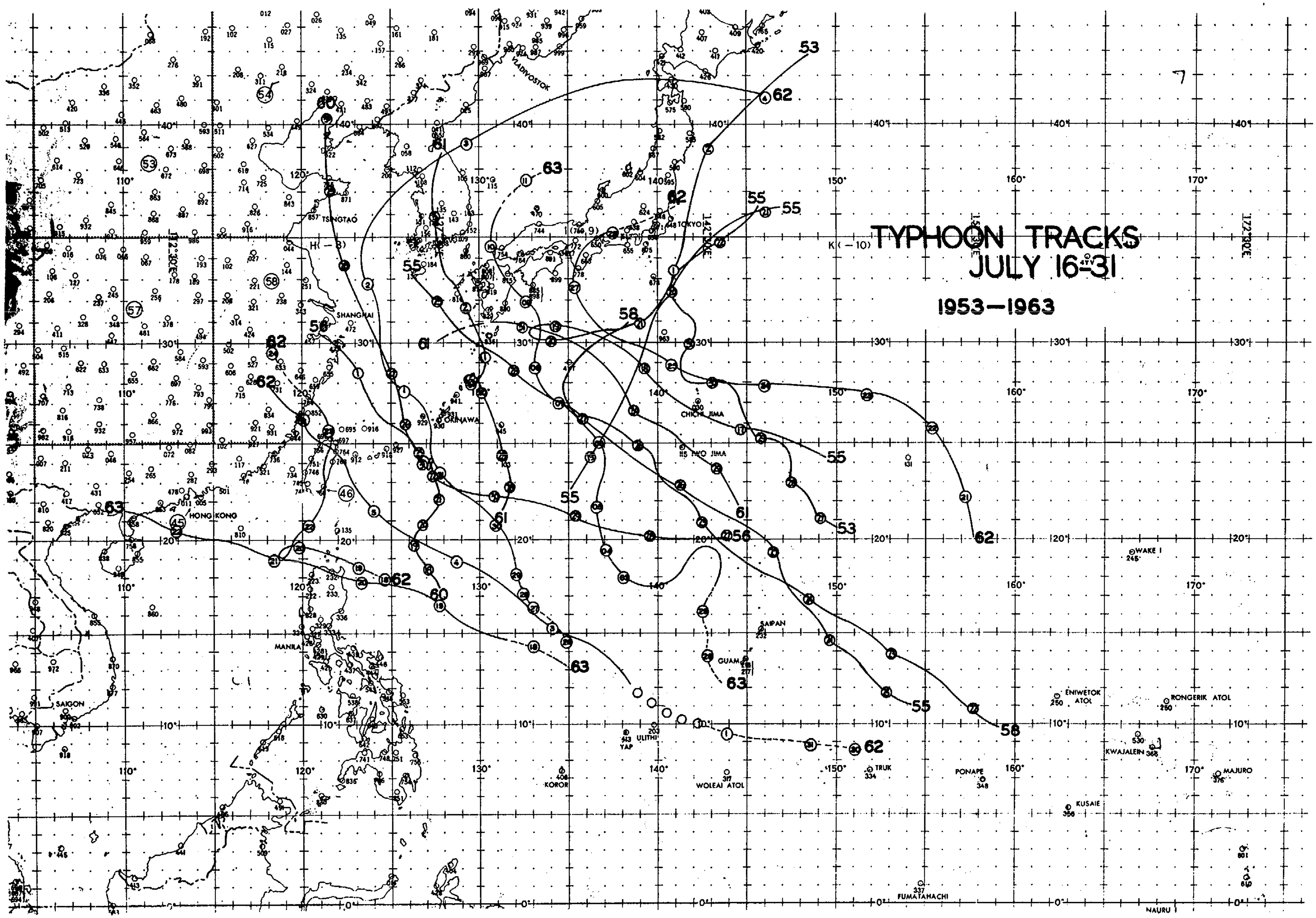
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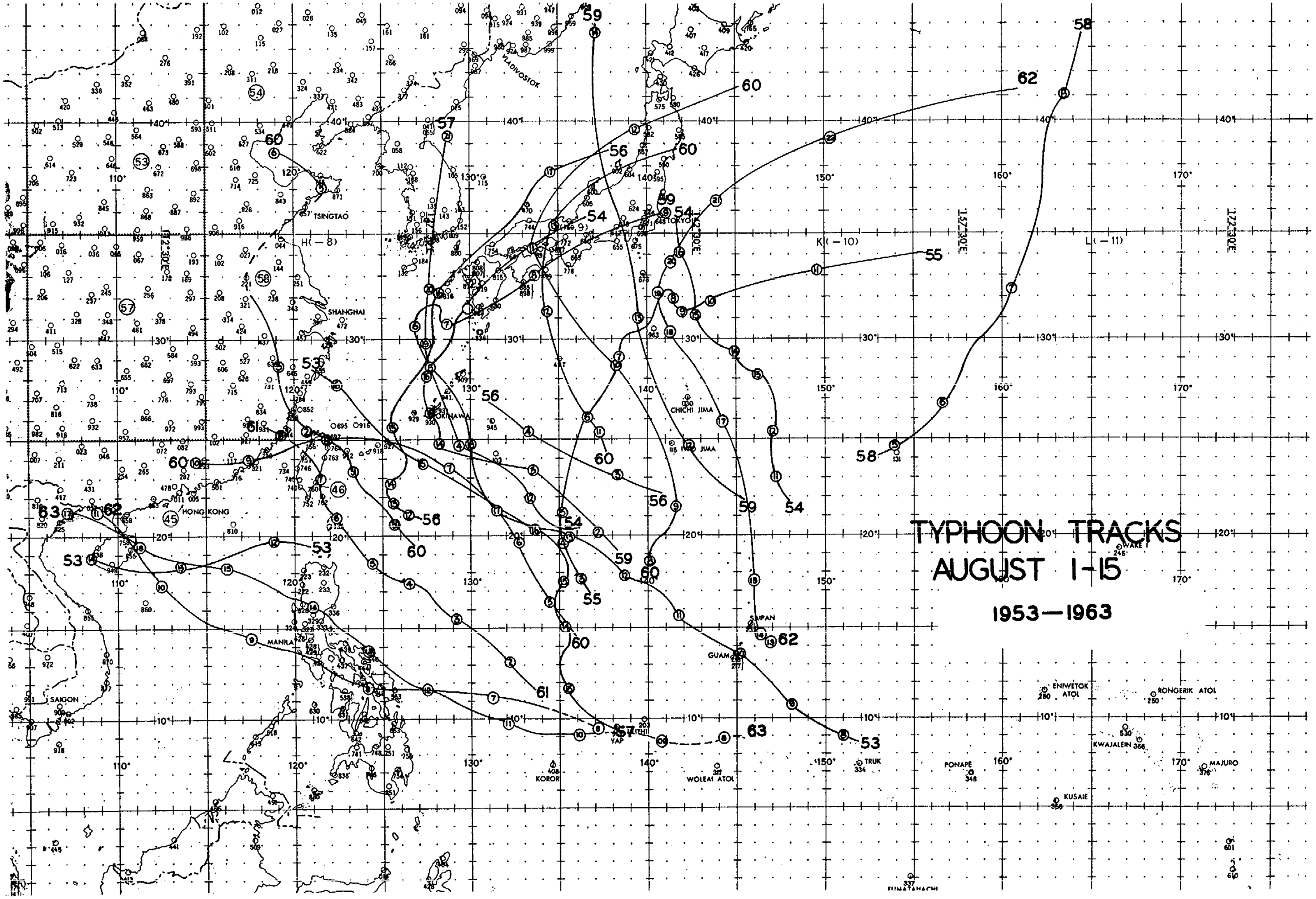
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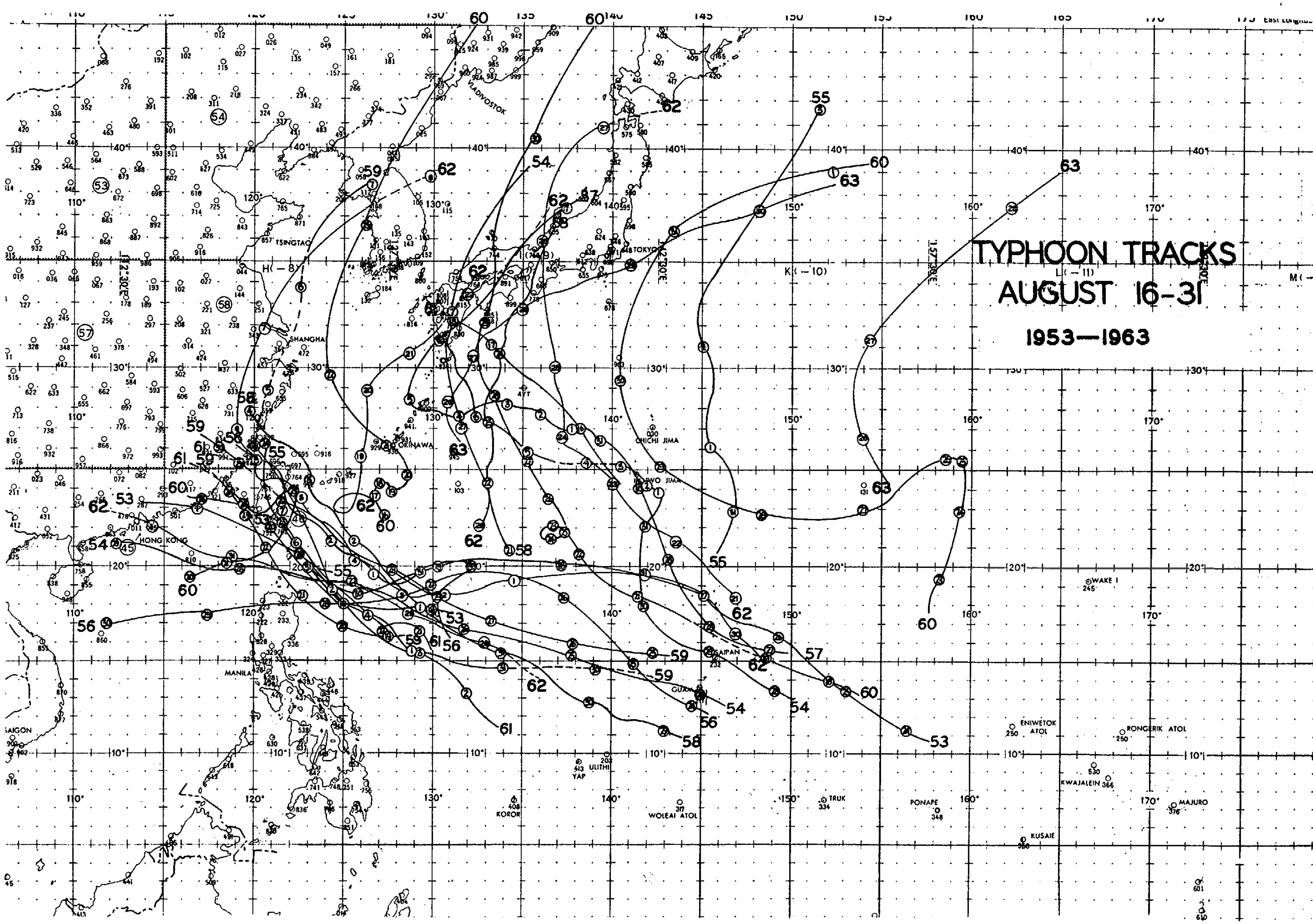
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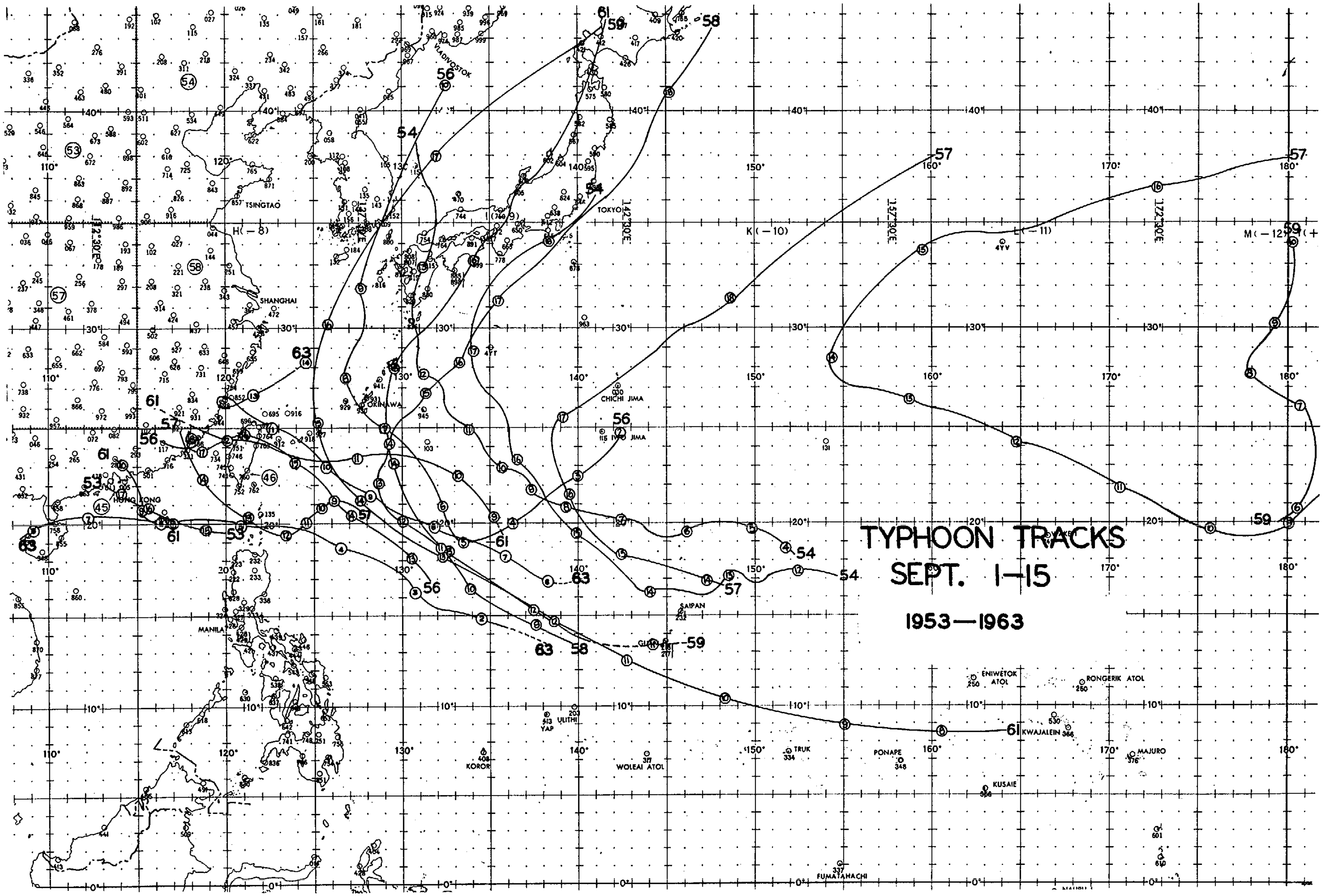

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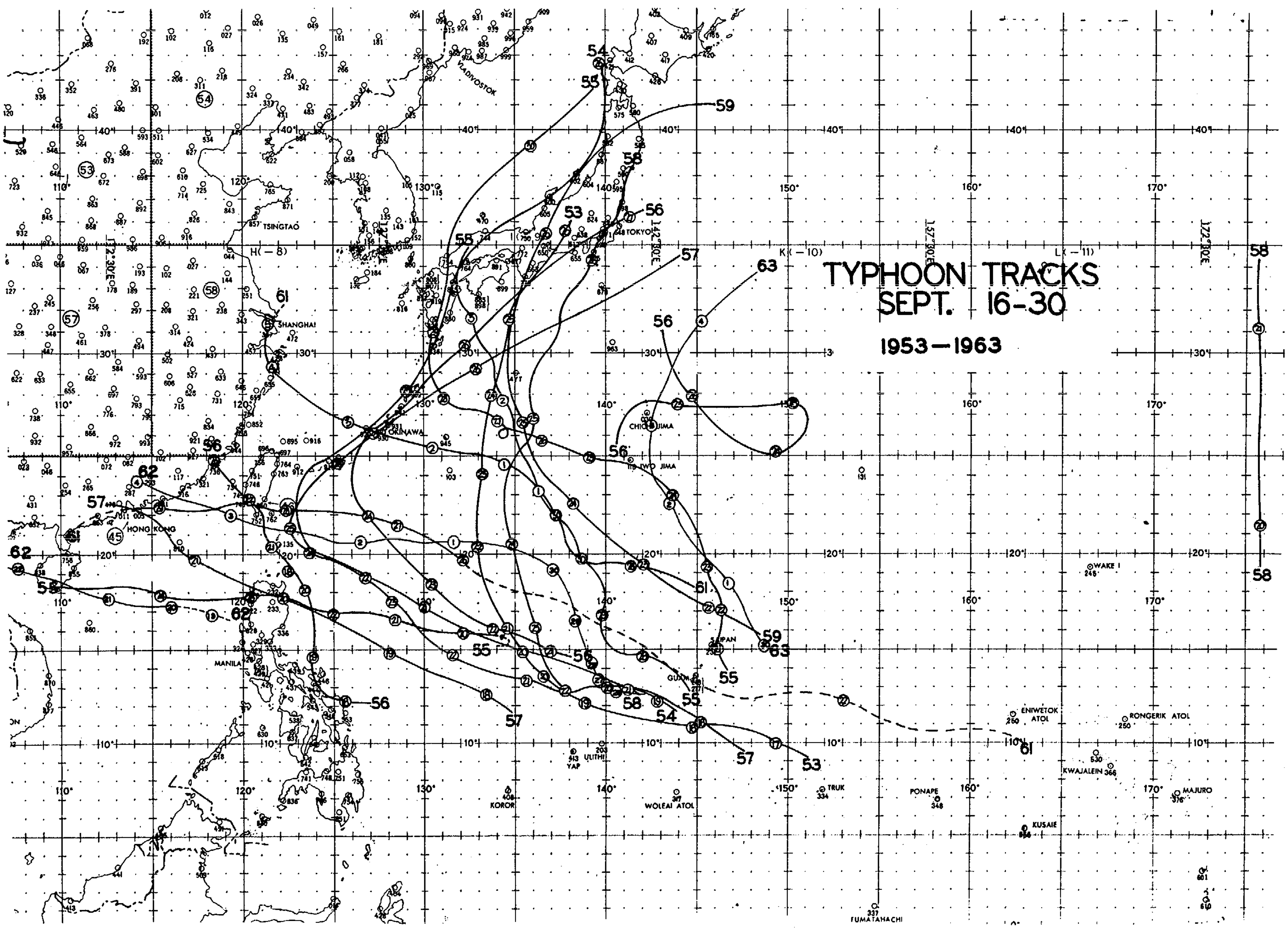
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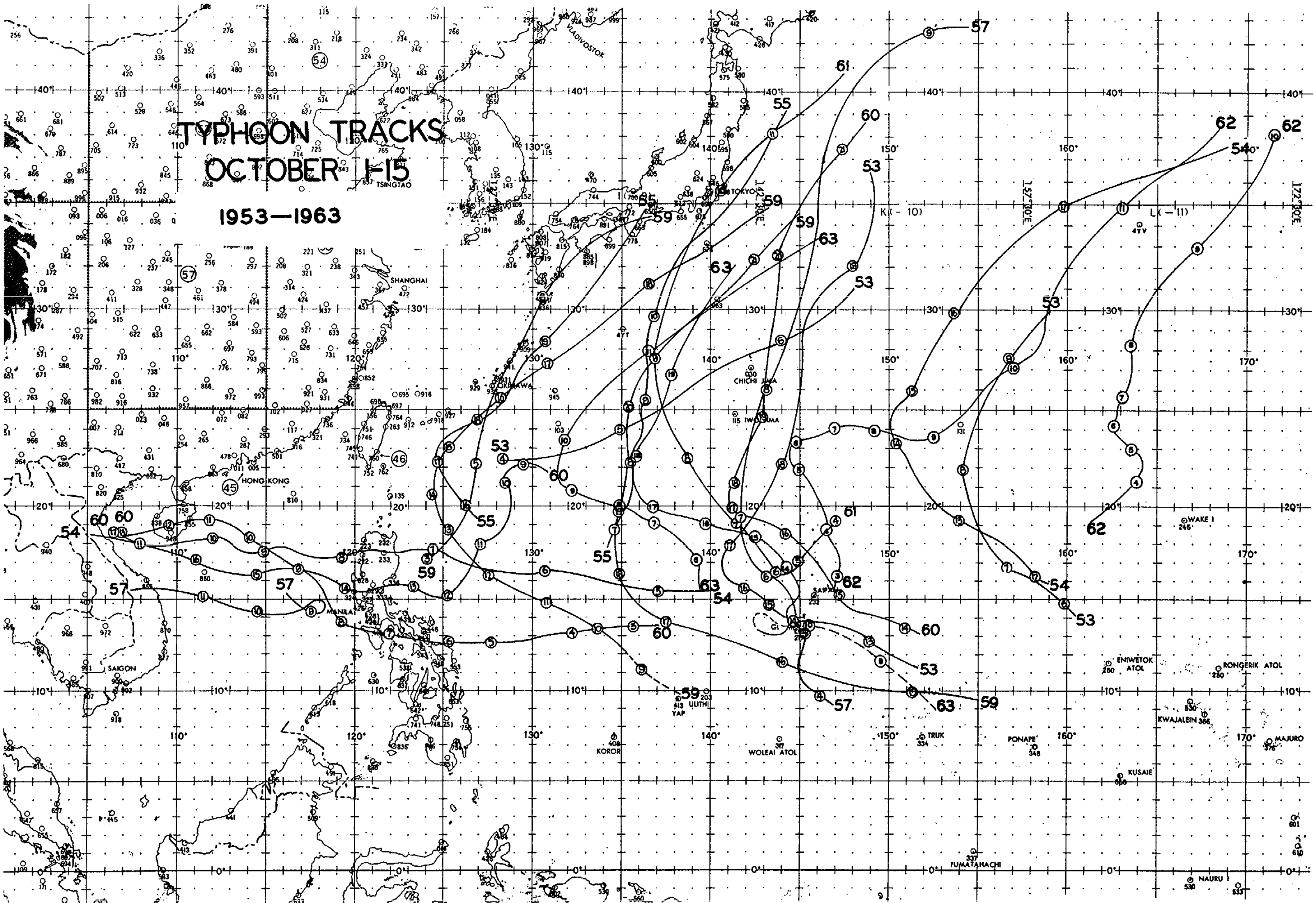

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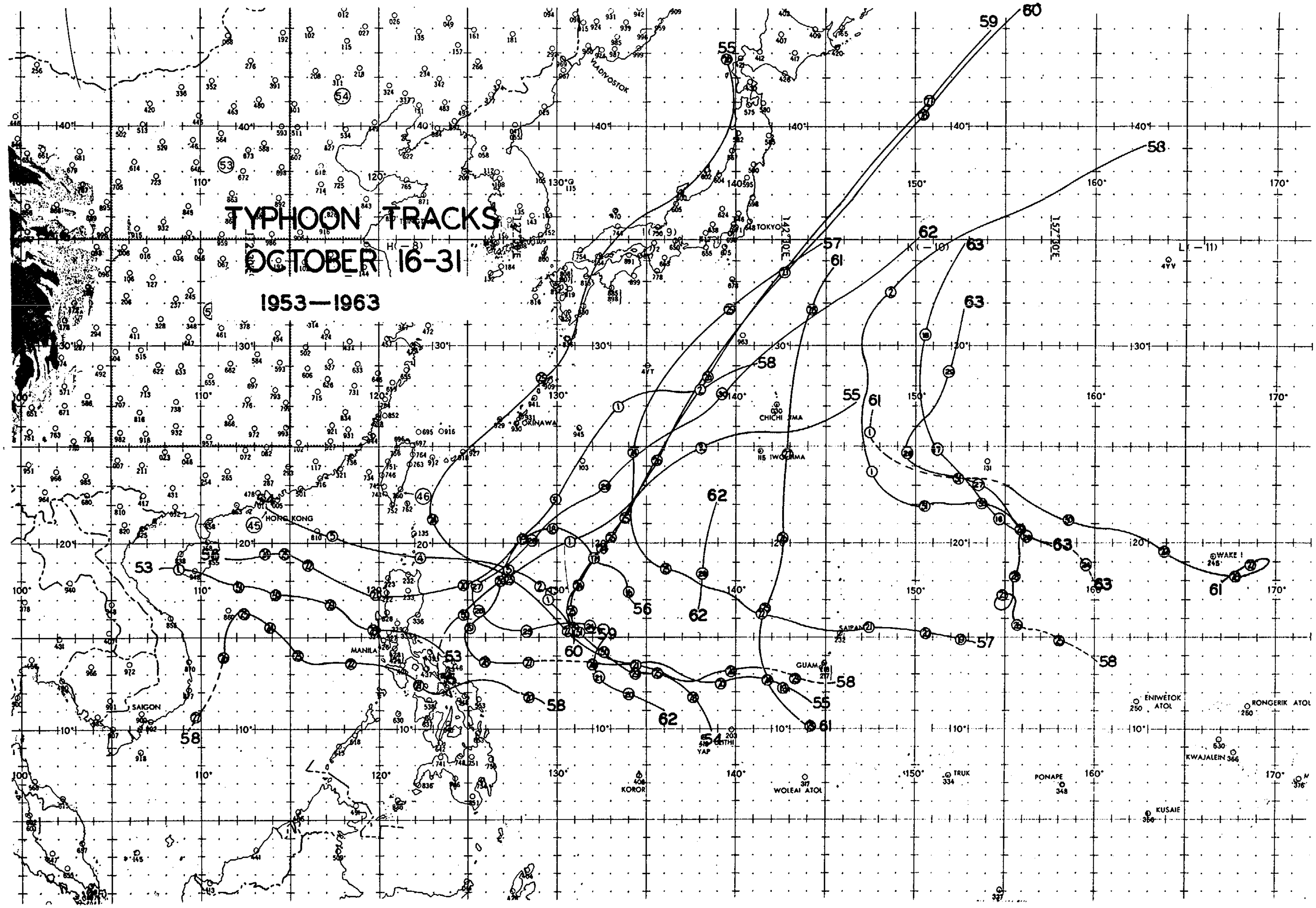
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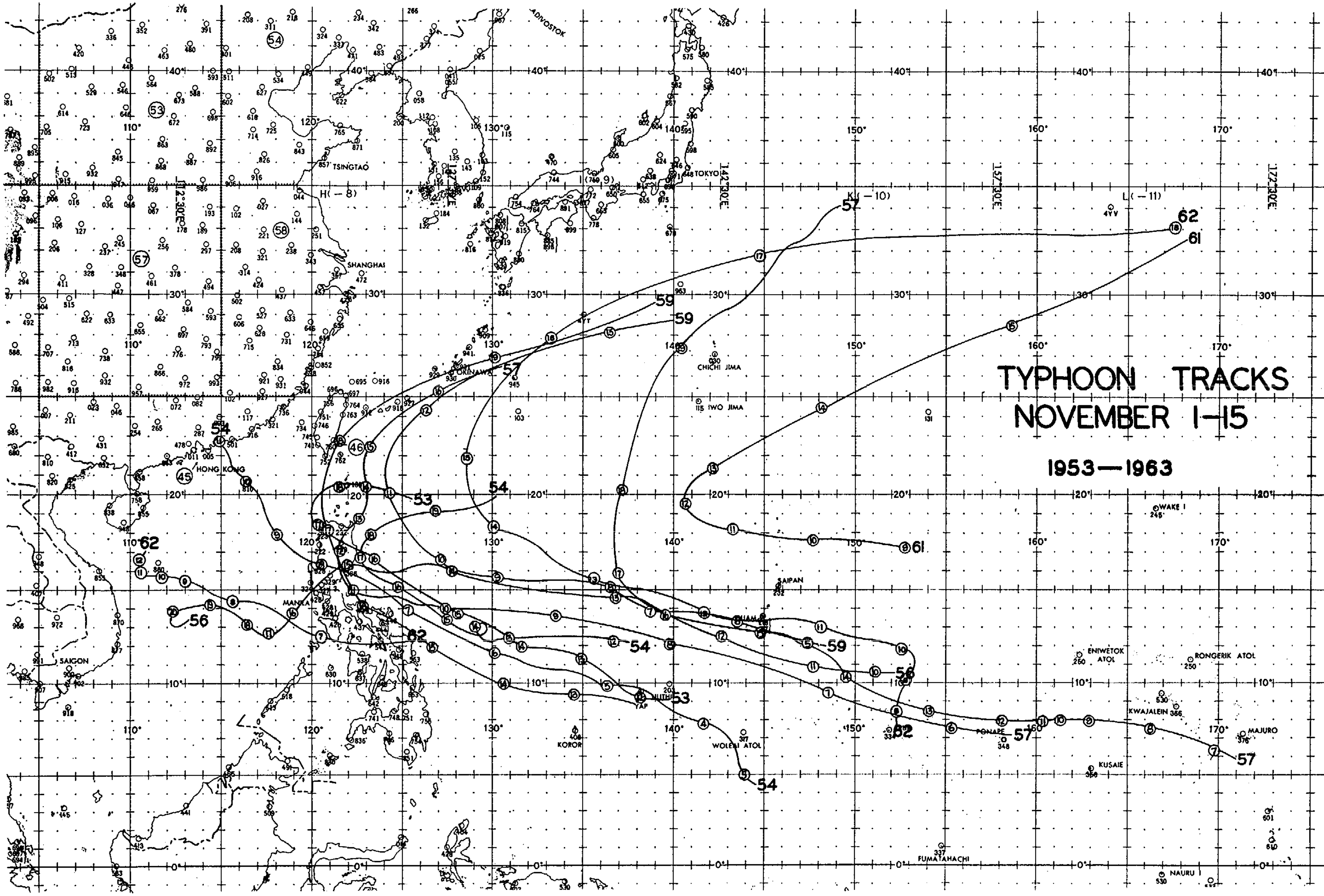
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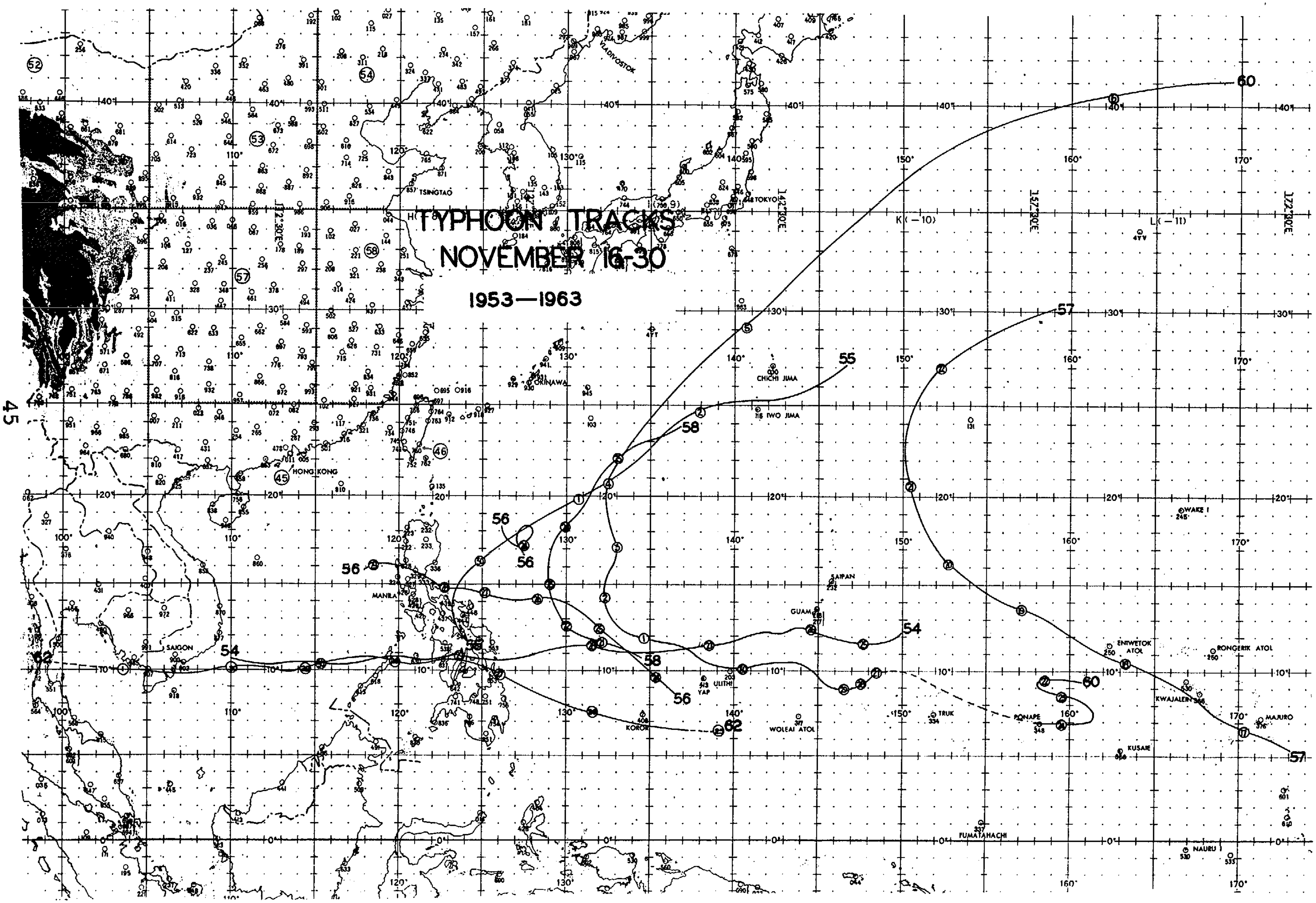
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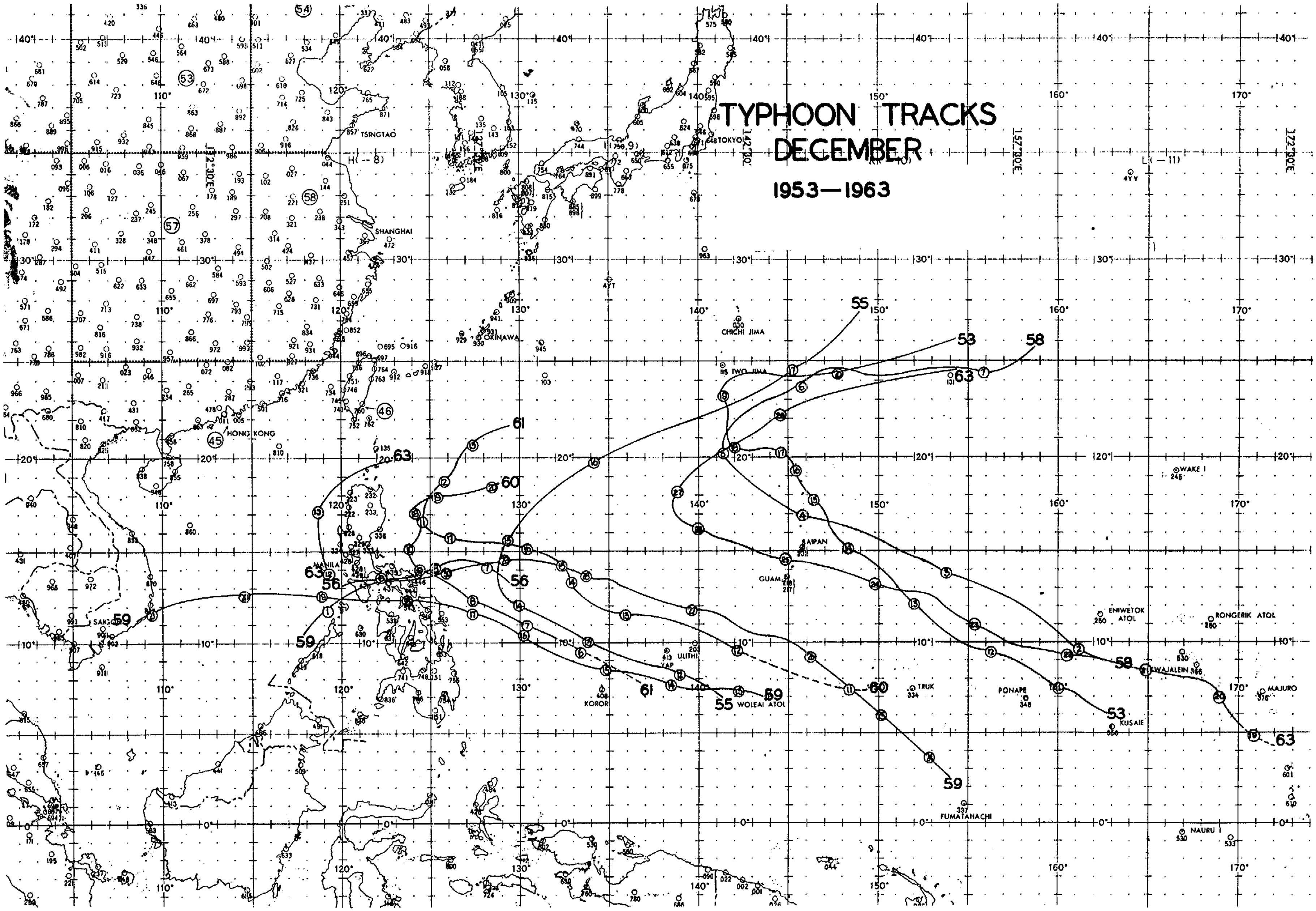
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